Venus Safe Landing Technology

Completed Technology Project (2015 - 2018)

Project Introduction

Even though Venus is our closest planetary neighbor, there is limited information characterizing the Venusian surface. The last NASA Venus mission to include an atmospheric probe component was the Pioneer-Venus mission, which launched in the late 1970s, while the last successful Venus surface sample measurement was made by the Soviet VEGA 1 mission in the mid-1980s.

This project is geared towards developing the technology required to safely land a spacecraft on the surface of Venus, and will focus on three different components: 1) high temperature and pressure testing of laser-welded Inconel honeycomb crushable for landing impact attenuation, 2) dynamic landing simulations (Adams) to inform a Venus lander design and characterize its performance, and 3) Venus landing site analysis to determine requirements for a lander mechanical design, and to provide inputs into the Adams landing simulations.

Given the vast unknowns that remain, future missions to the surface of Venus will likely produce groundbreaking scientific discoveries, which has resulted in a strong push for Venus mission concepts in the most recent Planetary Decadal Survey. NASA's interest in Venus was also recently exhibited by the selection of two Venus mission concepts for Step-2 Discovery Program concepts.

From an engineering standpoint, Venus represents a challenging target for planetary exploration; surface temperatures of ~ 460 degrees celcius and surface pressures of ~ 92 bar are expected, and there is limited data that has adequate resolution to characterize the surface on scales of ~ 1 m (size of a typical lander). Therefore, in order to design a lander for Venus, some assumptions must be made about the environment on the planet's surface. These assumptions directly feed back into quantitative requirements that drive the mechanical design of a lander. Some examples of relevant surface environmental parameters that should be considered by designers include surface winds, rock distributions, and slope distributions for potential landing sites. Unfortunately, datasets acquired to this day by instruments onboard Venus orbiters have not been of sufficient resolution to characterize individual landing sites. However, existing orbital and ground-based observations, while limited, can be used in conjunction with geological interpretations to characterize potential landing sites for future landed missions.

In order to further the development of relevant Venus landing technologies, this project focused on three different topics: 1) high temperature and pressure testing of laser-welded Inconel honeycomb crushable for landing impact attenuation, 2) dynamic landing simulations (Adams) to inform a Venus lander design and characterize its performance, and 3) Venus landing site analysis to determine requirements for a lander mechanical design, and to provide inputs into the Adams landing simulations.

JPL_IRAD_Activities Project

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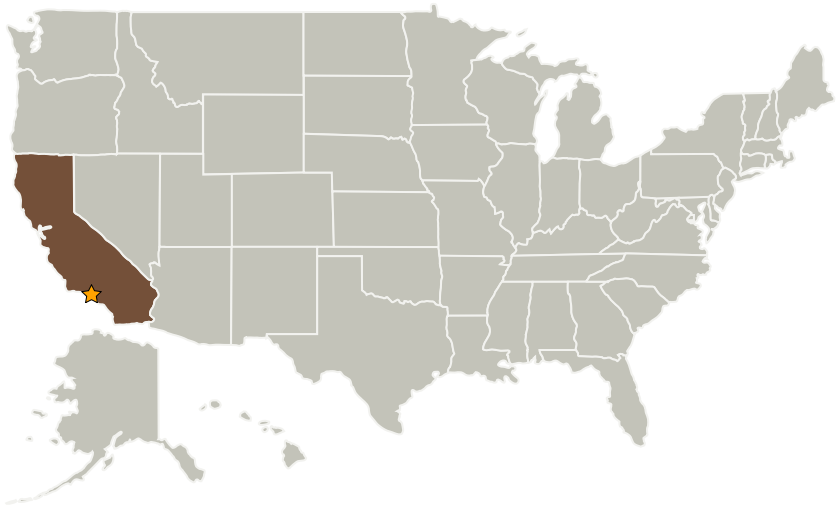
Anticipated Benefits

This project will enable future landed missions to the surface of Venus.

This project with further high temperature and pressure technology development and testing facilities, which can help other Earth based industries that work in high temperature and pressure environments, such as the oil industry.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Jason Rabinovitch

Co-Investigators:

Patricia J Aubuchon
John M Dunkle
Justin R Koch
Clara O'farrell
Gary M Ortiz
Michael T Pauken
Christopher C Porter
Laura Redmond
Jacqueline H Sly
Kathryn M Stack Morgan

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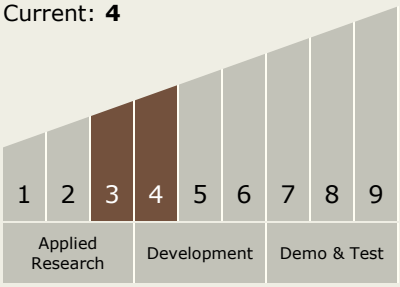
Images

JPL_IRAD_Activities Project Image
JPL_IRAD_Activities Project
(https://techport.nasa.gov/image/26028)

Technology Maturity (TRL)

Start: **3**
Current: **4**



Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.3 Landing
    - TX09.3.1 Touchdown Systems

Target Destinations

Others Inside the Solar System, Foundational Knowledge

Supported Mission Type

Push